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AUTHOR Symington, David; And Others
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ABSTRACT

The stand taken in the Learning in Science Project (Primary)--LISP(P)--is that primary school science should be centrally concerned with children's present interaction with their world rather than their future science education. Further, it has been decided that one of the LISP(P) foci should be on questions that children ask and how these questions should be handled in the classroom. This paper: (1) discusses questions that children raise and the ideas they have about possible answers to these questions; (2) describes preliminary attempts to probe children's thinking in these areas; (3) suggests procedures to build science activities based on children's present interaction with the world; and (4) discusses procedures for gathering data, both as part of research and part of teaching, which would examine such areas as the types of relevant science questions which occur to students, possible answers students can suggest for a particular situation, and methods students use to answer a question. These procedures include individual interviews, group interviews, and classroom observation techniques. Included in an appendix is an exploratory study of chi dren's questions and answers about wood. Information from the study was used to propose the various methods of data gathering suggested in the paper. (JN)

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LEARNING IN SCIENCE PROJECT (PRIMARY)

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PROCEDURES FOR EXPLORING ASPECTS OF PRIMARY SCHOOL PUPILS' VIEWS OF THE WORLD

Science Education Research Unit
University of Waikato
Hamilton, N.Z.

SE 045 307

Working Paper No. 105

PROCEDURES FOR EXPLORING ASPECTS OF

PRIMARY SCHOOL PUPILS' VIEWS OF THE WORLD

David Symington, Roger Osborne, Fred Biddulph and Peter Freyberg

September 1982

A Working Paper of the Learning in Science Project

(Primary)

Working Paper No 105

INTRODUCTION

The stand taken in LISP(P) is that primary school science should be centrally concerned with children's present interaction with their world rather than their future science education. Further it has been decided that one of the LISP(P) foci should be the questions that children ask and how these questions should be handled in the classroom (Symington, Osborne, Freyberg and White, 1982).

This paper deals with some of the issues which arise when we begin to explore what these decisions mean in practice. It deals with the questions that children raise and the ideas they have about possible answers to these questions. The paper describes our preliminary attempts to probe childrens' thinking in these areas. From these explorations suggestions are made as to procedures which could be used in the LISP(P) and elsewhere to further our ability to build science activities based on childrens' present interaction with their world. In particular the paper discusses procedures for gathering data, both as part of research and as part of teaching, which would indicate:

(i) questions with relevance to science which occur to pupils;
(ii) which questions, amongst those they think of, are of most interest to them;
(iii) the possible answers which children can suggest for a particular question;
(iv) those answers, from amongst those suggested, which pupils find to be most appropriate;
(v) the methods which children use when attempting to check the validity of an answer to a question;
(vi) their success in establishing the validity of answers to questions.

PUPILS' QUESTIONS

The questions pupils ask provide a valuable guide to their perception of their world. The questions they can construct indicate both what they know and what they realize they don't know. Of course, the gaps which they see in their knowledge and understanding reflect their view of the world and will not necessarily match up with what adults will identify as the gaps in their knowledge. Many science programmes have been built

upon adults' views of what children don't know and what they should know.

To take seriously the challenge of devising a science programme based on children's present interaction with the world means that the pupils' questions must be treated adequately. Although some science programmes have in the past attempted to begin from childrens' questions their commitment to 'hands-on' enquiry has meant that greater attention has been paid to questions which lead to such enquiry than to other questions. The approach of this project is to attempt to come to grips with the questions which are important to children irrespective of whether or not they lead to 'hands-on' enquiry.

ANSWERS

Children have ideas about possible answers to their own and their peers' questions. These can give considerable insight into the way they view the world, what the questions they ask mean to them, and the sorts of answer which they will be able to comprehend.

Primary teachers will frequently solicit pupils' ideas about what the answer to a question may be. However, most of the suggestions pupils make in science lessons are discarded because teachers are operating on the assumption that there is only one correct answer to a question. We think that this assumption neither reflects reality nor is educationally desirable and we will now attempt to explain our position.

Reality: Firstly, we consider that the notion of a single correct answer does not reflect the thinking of scientifically literate adults. This point emerged clearly in the debate on centrifugal force in a Melbourne newspaper, The Age, in 1981 (discussed in Gardner, 1981). To illustrate the matter here, consider the question: Why are the drops of water, sitting on a sheet of waxed paper, the shape they are? A scientifically literate adult could reply to the question with any one of the following responses, none of which is incorrect:

(i) Because they are sitting on waxed paper;

(ii) Because of the electrical forces operating between water molecules;

(iii) Because of hydrogen bonding;
(iv) Because water is a relatively cohesive substance;
(v) Because of the surface tension of water;
(vi) Because the liquid is water;
(vii) Because of the properties of water.

Some answers may be considered more appropriate than others but in deciding how appropriate a particular answer may be we would need to consider criteria such as the audience for the answer and the purpose of the answer.

Educational desirability: Let us now turn to the educational desirability of giving detailed consideration to the range of answers pupils might generate in response to a particular question. There are several reasons why we believe the full range of pupil ideas should be explored.
Firstly, even apart from the fact that a range of valid answers to a question reflects reality, the answers pupils give provide important insights into their current understanding of the natural, physical and technological world. For example, consider the following answers which children have proposed in response to the question : "Why do trees have bark?";

To make the trees look nice.
Bark is like a skin.
It's just the way God created it.
It's just part of the tree.
To protect the tree.
To keep moisture in.
To protect against infection.
It is used for homes for insects.
It catches rain water so the tree can feed on it.

These answers give a good measure of the understandings of the children who suggested them. Some of the children obviously have a teleological view of the world. Some believe that the bark is there to give aesthetic enjoyment to humans. Others that the bark is there to provide a home for insects.

Other answers appear to reflect a belief that the bark is likely to have a part in the effective functioning of the tree - keeping moisture in or catching moisture to meet the needs of the tree.

Other examples later in the paper will further illustrate how consideration of possible answers can give significant insight into the child's present interaction with the world.

The children's range of answers will differ from that of a scientifically literate adult in that some of the children's answers will be invalid. For example, the tree does not 'feed upon' water caught by the bark of the tree. Invalid answers, however, reflect the current thinking of the child and should neither be ignored nor brushed aside. If that child is taught something else about the reasons why trees have bark the new information will not necessarily replace the old view. As we will see later in the paper we have found that children do not see one answer to the question as excluding another. Frequently they are willing to accept a wide range of possibilities as good answers to a question. One child can readily accept that trees have bark :

- so as to protect the tree, and,
- so that trees are strong and tall, and
- because trees look nice with bark, and
- because bark makes a home for lots of insects and spiders.

It is necessary therefore that pupils be given the opportunity to test the validity of their ideas. In that way there will be an opportunity for them to see which of their ideas are valid and hopefully to reject those that are invalid.

A second important reason why teachers should treat seriously all of the answers children suggest, is that the answers can provide the base for effective classroom activity. Each idea can be subject to some form of scrutiny. Some can be tested by practical investigation. For example, if a child suggests that the water drops sitting on a surface are round because they came from the round opening of a dropper the idea is immediately testable. Others can be tested by reference to books. For example, the idea that bark stops the loss of water from a tree can be tested by consulting reference books on trees. Yet others can be

scrutinized by discussion. For example the suggestion made by one child that bark on a tree is analogous to a man growing whiskers can be considered in discussion. The class could discuss the extent to which the analogy is a meaningful and useful one.

PURPOSES OF THE DATA GATHERING

To this point in the paper we have been concerned with why teachers should take an interest in these particular aspects of children's thinking. We turn now to consider what data we think the LISP(P) should gather and our reasons for advocating the collection of such data.

We suggest that, as part of LISP(P), evidence be gathered on (i) childrens' questions, (ii) childrens' ideas about possible answers to these questions, and (iii) children's ideas about how to answer the questions and check the answers across a range of topics.

These data could be put to two uses :

(a) They could be used to test the assumptions upon which the earlier parts of this paper have been built e.g. that pupils are able to generate sensible questions and sensible ideas about what the answers to a question may be. That is, the data will test parts of the model of primary school science which has been developed within LISP(P) to this point.

(b) They could be used as a fund of information on children's thinking which can strengthen teachers' feelings of control over the curriculum in that when they begin a topic they will be aware of the questions the pupils are likely to be interested in pursuing and the ideas they have about what the answers to these questions may be and about what are appropriate methods of arriving at answers to the questions.

This, of course, assumes that for a given topic there is likely to be significant uniformity with respect to children's thinking across particular age groups. This assumption seems justified on the basis of the experience of LISP (Forms 1-4) and our experience with typical primary classes. However, no matter what our current views, the data collection will soon confirm or refute the assumption.

The type of information which we propose should be gathered, is potentially of great significance to teachers because :

(i) It would enable them to anticipate their children's thinking. No matter what the objectives of the subsequent plans of a teacher, once the children begin to interact with the materials and the ideas of a topic, their interests will jump outside the programme devised by the teacher. For example, if the teacher introduces the topic of wood expecting that the children will be involved in investigating the flexibility and strength of wood, he or she is likely to find that the children will have questions (e.g. why do trees have bark?) which fall outside the plan devised. If the teachers have no forewarning of the nature of these digressions they may well feel that their control over their intended curricular material is weakened. We anticipate that data gathered during the LISP(P) will prepare teachers to deal with such situations - that is, the project will enable teachers to feel more in control of the curriculum.

(ii) It would enable them to provide learning experiences which match their pupils' present interaction with the world. They should be able to devise programmes based not on what adults think children should know but based on what LISP(P) has established that children want to know. Pupil motivation is likely to be greatest when they are enabled to find answers to questions in which they are themselves interested.

THE CONTENT OF DATA GATHERING

To meet these expectations we propose that data gathering be carried out in three situations :

(i) in interviews with single pupils;

(ii) in interviews with groups of pupils;

(iii) in classrooms during science activity based on the LISP(P) model of primary science.

(i) Individual interviews are necessary because we wish to base our work on the present interaction with their world, by typical children, not on such interaction of the more vocal children.

(ii) Interviews with groups of pupils are also desirable because very often children choose to, or are directed to, work in groups and it is the group which carries out the activity in which possible answers are evaluated. Further, verbal interaction within groups can be creative. Ideas can emerge from group interaction which the group members individually may never have generated. The research should not overlook this part of the curriculum as it is experienced in the classroom.

(iii) Observation of classrooms. LISP(P) is based on a model of primary school science. The questions being asked in the interview situation reflect the assumptions of this model. That is, there is a specific link between the research being undertaken and the expected use in the classroom of the data gathered. It is imperative therefore that concurrent with the collection of data by interview the model itself be explored in the classroom.

PROPOSED METHODS OF DATA GATHERING

Some of the proposed procedures have already been tested and these are described in the Appendix. On the basis of this earlier work, as well as previous interviews and classroom observation, a variety of further procedures is proposed.

A. Individual interviews about pupil's questions and answers

Two types of interview work are planned:

(a) Work with individual children. An in-depth analysis over an extended period of time of a few children in terms of the types of questions they ask of themselves, of their peers, of their brothers, sisters and parents, and of their teachers, and in terms of what context motivates these questions, may well lead to useful unsights and provide a base line context for other students within the LISP(P). A study of the types of answers that children generate, and of the type of answers each child finds useful, would also be part of this investigation.

(b) Work on individual topics: Here we would propose individual interviews of a range of pupils to find with respect to a particular set of materials (e.g. a set of rocks, or blocks of wood, or a group of slaters), what questions these materials generate, what answers children generate to these questions, what childrens' views are of these proposed answers, and what methods children suggest whereby other answers may be found and/or proposed answers validated. Finally in the light of such information we would wish to find which answers children thought best and why.

A set of interviews with children involving the above questions would be a developing sequence. The initial interviews would concentrate on the early questions and then, as the data built up, the later questions could be more effectively introduced using the data from the earlier interviews. In some respects a grounded theory approach (Glaser and Strauss, 1976) would be relevant here, both for the ongoing development of the interview schedule and in the analysis and categorization of children's questions and answers. What topics, or more pertinently what situations, should be investigated? In the first instance we would introduce topics which appear to generate a lively interest with respect to questions and proposed answers. Situations easily established in classrooms, or through easily arranged field trips, would be obviously favoured and would provide situations "close to children" (Symington et.al., 1982).

B. Small group and full class studies

The work discussed above in A. under individual topics should also be undertaken in both small group situations (where the cross-fertilization of ideas may lead to new questions, proposed answers, and validating procedures being suggested by children) and in full class situations. The classroom-based research would normally follow interview-based research on a topic. Through full class studies, problems of management and control could be explored and evaluated.

While all the class may be involved in generating questions, and possible answers, it may well be impractical and quite unnecessary for the whole class to check on the validity of tentative answers

all at the same time; different groups could work on different questions and answers of particular interest to them at different times. What is important (Tasker, 1982) is that they feel that it is their problem that they are trying to solve. Whether it was a problem they generated themselves or is one they have adopted is immaterial provided it is now a problem they wish to solve. Whether or not children of various ages can accept and solve particular problems within the normal constraints and resources of the typical school setting needs to be carefully analysed and documented.

In these classroom-based studies it would normally be desirable to involve the classroom teacher in the planning and management of the work (see Appendix, Section C). In this way the likely acceptance of an approach to primary science teaching based on this research could be established.

SUMMARY

On the basis of earlier work on this Project (Osborne, 1982; Symington et al., 1982) details of a research programme have been explored and clarified. Some preliminary work described in the Appendix to the paper gives cause for optimism in terms of the likely productivity and success of such a line of research.

As a working paper of the Learning in Science Project (Primary) it is written to clarify our own ideas and gauge reaction to what we propose. For this reason we would appreciate any comments you may have.

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APPENDIX EXPLORATORY INVESTIGATIONS OF CHILDREN'S QUESTIONS AND ANSWERS

The following exploratory work was carried out by two of us (D.S. & F.B.) during July 1982. It provides information which in part, led us to propose the various methods of data gathering suggested in this paper.

A. Interviews about Pupils' Questions

The procedure adopted for investigating pupils' ability to generate questions and their interest in finding answers to questions was as follows :

(i) The interviewer produced the samples of wood contained in the kit provided for schools, together with several cross-sectional pieces cut from the trunks of trees. The pupil was encouraged to handle and examine these.

(ii) Each pupil was asked to suggest things that a scientist might know about wood but he/she didn't know. The whole interview was recorded on audio tape but each suggestion made by the pupil at this stage was recorded in longhand.

(iii) The interviewer then went, one by one, through the suggestions which the pupil had made in (ii) asking whether the pupil was really interested in filling in that gap in his/her knowledge.

(iv) Finally, the interviewer went, one by one, through the suggestions again asking how the pupil thought that he/she could obtain the necessary information.

(v) The whole procedure was then repeated for the topic of bones using as stimulus an assorted collection of bones.

Some notes on this procedure

1. The children's suggestions arising from this procedure are provided in Table I.

   It is of interest to note that -

   (a) although the samples of wood were introduced relatively few suggestions were made which related to the properties of wood. Rather the children asked questions about trees;

   (b) of the suggestions which did deal with the properties of wood, four of these came from a boy who had had extensive experience with wood because his father was a cabinet maker.

2. The form of the question asked was based upon the experience of Symington (1977). Later experience suggests that pupils could be asked simply to identify questions they have about wood/bones.

3. Later experience, together with consideration of the LISP(P) model of primary school science, would suggest that discussion of methods of finding 'answers' would be better left until consideration of possible answers.

4. The children who participated in this study were from a Standard 4 class. However, there is no reason to believe that the procedure would not be equally successful across the range being considered by LISP(P).

B. Interviews about Pupils' Ideas concerning Answers

The interview procedure followed for investigating pupils' ideas about possible answers to questions was as follows :

(i) Before the interview three questions which pupils were known to have asked were selected and for each of these the authors and colleagues generated a range of possible answers. These were typed up for inspection by pupils.

(ii) The interview began by the interviewer asking the pupil if s/he had any questions about 'bark'. A cross-section of a tree trunk of pinus radiata was placed in front of the pupil. The entire interview was recorded on audiotape.

(iii) The pupil was then shown the question 'Why do trees have bark?' and asked what s/he thought the answer to this question might be.

(iv) The pupil was then shown one by one the list of possible answers to the questions. The pupil was asked to say for each whether he/she thought that it was a good answer to the question. Reasons were sought whenever the pupil claimed that an answer was unsatisfactory.

(v) Upon completing the list the pupil was asked to select what he/she thought was the best answer.

(vi) A Camelia leaf was then introduced and the entire procedure repeated. The question posed for the pupils' consideration was in this instance 'Why is the leaf that shape?'

(vii) Three drops of water were placed by means of an eye dropper onto a metal tray. The question posed for the pupils' consideration was in this instance 'Why are those drops of water round?'

Some notes on this procedure

1. The pupils' responses to the questioning about the status of the answers is included in Table II.

It is worth noting that

(a) there was considerable variation between pupils in their views of which were 'good' answers to the questions. This highlights the need to continue to interview individual pupils.

(b) Each pupil accepted a large range of answers as good answers to a question. That is, acceptance of one answer as a good answer did not necessarily lead to rejection of answers of a different type. These data support the assumptions of the model of primary science proposed in this paper and in Symington et al (1982).

(c) Of importance are the reasons given for rejection of answers as appropriate. These can be summarised as follows :

Rejection of the answer because of factors peculiar to that answer.

(i) The child has evidence which enables rejection of the answer e.g. When considering the question 'Why are the drops of water round?' some children rejected the answer 'because of the tray they are on' because they knew that water formed round drops on a variety of surfaces.

(ii) The child rejects the analogy used e.g. When considering the question 'Why are those drops of water round?' some children rejected the answer 'Because water's got a skin that pulls it in'. They did not consider it useful to talk about water having a skin.

(iii) The child does not understand the answer.

Rejection of the answer because the form of thinking used is rejected.

(i) Some children rejected an answer because they considered it inappropriate. For example 'because water likes to be round was rejected by some children who said that they did not believe that water could express a preference.

(ii) Some human-centred answers were rejected, e.g. some children did not believe that bark would exist because it looks nice to humans.

(iii) Some children rejected an answer based simply on naming, as an appropriate form of answer e.g. a number of pupils rejected as an appropriate answer 'Bark is the name we give to the outside of all trees'.

2. The answers being considered were some proposed by the authors and by colleagues based on previous work with children. It would be better for further research on this issue if the answers being considered were ones generated by children at the same grade level.

3. The children who participated in the trial were from a Standard 4 class. However, there is no reason to believe that the procedure could not be used with equal success at any of the grade levels being considered in the LISP(P).

C. Classroom Observation

For this trial one of the authors conducted a session with a composite Standard 3/4 class. The procedure followed was :

(i) The children were introduced to the topic - bark - and given an opportunity to tell the rest of the class and the teacher some of the things they know about bark.

(ii) The children were then asked to suggest questions about bark - that is, to identify things they didn't know about bark. These were listed on the blackboard. (see Table III).

(iii) The teacher chose one from those questions suggested - 'Why do trees have bark?' - and asked the children to think of possible answers to the question. They were given cards and given the opportunity to work singly or in small groups to record one or more possible answers to the question.

(iv) After a time the children were called together and asked to either read out the answers they had suggested or to hand in the cards so that the teacher could read out the answers they had suggested. These possible answers were then listed on the blackboard. (See Table III).

(v) The children were then asked to select one of these answers so that they singly, or in their groups could check on that answer. The

teacher conducted a discussion in which it was established that there were several possibilities for checking answers :

- Experimenting. Discussion of this method included comment on ethics, and the need to balance our desire to know against other issues such as the value of a tree to the community.
- Consulting books. Discussion of this method included comment on key words which could be useful in finding information on bark in books - bark, tree, plant, etc.
- Consulting people. Discussion of this method included comment on people most likely to be able to provide information on this topic.

(vi) The children were asked to follow up the answer in their own time during that or the following day.

(vii) Two days later those pupils who had given some time to the task were interviewed individually or in groups, depending upon how they had worked. The questions for the interviews, which were audiorecorded, were:

(1) What answer were you checking on?
(2) What have you been able to find out?
(3) Do you think it is a good answer or not to "why do trees have bark?"?
(4) Let's look at all the other answers.

What do you think about them?

(5) Why did you choose to look at the answer you did?
(6) Which questions do you think are good questions?
(7) Which questions would you be interested in finding answers to?

The children were also asked about their methods of checking on the answers. Of the seven children interviewed, four reported looking in a book or encyclopaedia in the school library, one described a practical activity which he had undertaken, and two mentioned that they had just 'thought about it'. Thus five had followed one or other of the three

suggested methods but two had used a method which lay beyond those suggested, namely a self-consulting procedure. In connection with what the children had actually investigated, it seemed to the interviewers that the seven pupils had all reverted to seeking an answer to the original question (Why do trees have bark?) rather than attempting to validate a chosen answer. Future research will need to give consideration to both of these issues.

Some notes on this procedure

1. Of the questions suggested the teacher chose the one to which he had given some thought. In future research it would appear desirable to be equipped to cope with a wider range of questions so that children could pursue those questions which are of most significance to them.

2. It is heartening to note that the possible answers suggested by the pupils are very similar to those used in the trial just reported.

3. In this case the children had only limited opportunity to check on the validity of the possible answers. In future research it would be better if the class teacher accepted responsibility for the whole activity and the pupils be given greater opportunity as part of the classroom programme to check on the validity of possible answers.

TABLE I: CHILDREN'S QUESTIONS ABOUT WOOD

SUGGESTIONS ABOUT TREES RATHER THAN WOOD

DOES THE TREE WIDEN AS IT GETS OLDER?
HOW COME A LOT OF TREES ARE BIGGER THAN OTHERS?
HOW DOES WOOD TURN INTO COAL AFTER MILLIONS OF YEARS?
WHY DOES WOOD TURN INTO COAL?
HOW CAN YOU TELL HOW OLD A TREE IS?
WHY DO TREES NEED BARK?
WHAT ANIMALS LIVE IN IT?

SUGGESTIONS IN WHICH OBSERVATIONS OF WOOD LINK TO TREES

HOW DO WE KNOW WHAT TYPE OF WOOD IT IS?
IS IT TRUE THAT THE LINES TELL YOU HOW OLD THE TREE IS?
HOW THE GRAIN GETS IN IT.
HOW IT CAN BE ROUGH AND SMOOTH IF YOU CUT IT DIFFERENT WAYS.
HOW THE COLOUR GETS IN SOME WOOD.
WHY DO THEY HAVE THE LINES?
WHY IS THE BARK A DIFFERENT COLOUR TO THE WOOD?

SUGGESTIONS ABOUT THE PROPERTIES OF THE WOOD

WHY IS SOME WOOD LIGHTER THAN OTHER TYPES OF WOOD?
HOW IS WOOD FLAMABLE?
HOW DO WE KNOW WHICH WOOD IS GOOD FOR MAKING HOUSES, FOR FIRES ETC.?|||
HOW GOOD IS THE WOOD? IS IT LIKELY TO SPLIT?|||
HOW VALUABLE DIFFERENT WOODS ARE. |||
WHY SOME WOODS ARE WATER RESISTANT AND OTHERS AREN'T.|||

||| FATHER A CABINET MAKER.

TABLE II: PUPILS RESPONSES TO QUESTIONING ABOUT ANSWERS

✓ THINK IT'S A GOOD ANSWER ✓✓ BEST ANSWER(S)
X DON'T THINK IT'S A GOOD ANSWER

CHILD	1	2	3	4	5	6	7	8	9
A. WHY DO TREES HAVE BARK?									
1. It's like the skin on people and the fur on animals	✓✓	x	✓	?	✓✓	✓	✓	✓✓	✓
2. Because trees look nice with bark	x	✓	x	✓	x	x	x	✓	✓
3. Because bark makes a home for lots of insects and spiders	✓	✓✓	✓	✓	✓	✓	x	✓	✓
4. It's just part of the tree like the roots and the leaves	✓	✓	x	✓	✓	✓	✓	✓	✓
5. Bark is just a name we give to the outside layers of trees	x	✓	x	?	✓	x	x	✓	✓
6. The sun made the outside go brown	x	x	x	✓	x	x	x	?	x
7. Bark is the name we give to the outside of all trees	x	✓	x	✓	✓	x	✓	x	✓
8. Bark is made up of cells that are different to the cells in other parts of the tree	✓	✓	✓✓	?	x	✓	?	✓	✓
9. Bark protects the inside of the tree	✓	✓✓	✓	✓	✓	✓	✓✓	✓	✓
10. If you didn't have bark it wouldn't be a tree	✓	✓	x	✓	x	?	✓	x	✓
11. So that trees are strong and tall	x	✓	✓	✓✓	x	✓	x	x	✓✓

TABLE II (cont)

B. WHY ARE THOSE DROPS OF WATER ROUND?	CHILD 1	2	3	4	5	6	7	8	9
1. Because they came out of a round opening	✓✓	✓✓	x	x	x	✓	x	✓	✓
2. Because water is a clingy liquid and it pulls together	x	✓	✓	✓	✓	✓	?	✓✓	✓
3. Because of the tray they are on	x	x	x	x	x	x	x	x	✓
4. Because that's nature's way	✓	x	x	?	x	✓	✓	✓	✓✓
5. Because they're like bubbles and bubbles are round	✓	✓	x	✓✓	x	✓	x	x	✓
6. Because water particles attract one another	✓	?	✓✓	?	✓✓	✓	x	✓	✓
7. Because God made them that way	✓✓	x	✓	x	x	✓	✓	✓	?
8. Water likes to be round	x	x	x	x	x	✓	x	x	?
9. Drops are always round	✓	✓	✓	x	?	✓	x	✓	✓
10. Because water's got a skin that pulls it in	✓	?	x	?	✓	✓	x	x	?
11. Most things in nature are even	✓	?	✓	✓	x	✓	✓	✓	✓
12. Because of the shape of the drop	x	x	x	✓	✓	✓	x	✓	✓
13. Because it's water	?	x	x	x	x	x	x	✓	✓

TABLE II (cont)

C. WHY IS THE LEAF THAT SHAPE?	CHILD 1	2	3	4	5	6	7	8	9
1. Because all the leaves on those trees are that shape	✓	x	x	✓✓	✓✓	✓✓	x	✓✓	x
2. Because God made them that way	✓	✓	✓	x	x	✓	✓	✓	x
3. Because it's the best shape for the leaf	✓	✓	✓	✓	x	x	x	x	✓
4. So that it can catch rain	x	x	✓	✓	x	✓	x	x	✓✓
5. So it can get a lot of sunlight	x	x	x	x	x	x	✓	✓	✓
6. Because it looks nice	✓	x	x	✓	x	x	x	✓	✓
7. Because that's the way it grows	✓✓	✓✓	x	✓	✓	✓	✓	✓	✓
8. Because it's got the same shaped leaves as the parent tree	✓	?	✓	?	✓	✓✓	✓	✓	✓
9. Because when the leaves come out of the branch they're that shape	✓✓	?	x	✓	✓	✓	✓	✓	✓
10. Because nature always has even shapes	x	✓	?	✓	✓	✓	✓✓	✓	✓
11. It has inherited that shape from the tree's parents	✓	✓	✓✓	x	✓✓	✓	✓	✓	✓
12. The edge keeps insects off	?	x	x	x	x	?	✓	✓	x

TABLE III

QUESTIONS CHILDREN ASKED ABOUT BARK (tree) DURING SPECIAL LESSON WITH DAVID SYMINGTON

1. Is bark just old wood?
2. Why does bark grow only on the outside of trees?
3. Why is it brown?
4. Why do trees have bark?
5. How long would it take to rot?
6. What is the average thickness?
7. Why is it rough?
8. How is it made?
9. Why is it only on trees?

ANSWERS SUGGESTED/GENERATED BY THE CHILDREN TO QUESTION 4 ABOVE

1. To protect the trees
2. To make the moss look attractive
3. To make the tree look old
4. So the bugs don't rot the tree
5. To stop the tree rotting
6. Bark is like a skin
7. It catches rain water so the tree can feed on it
8. To protect against storms
9. To keep it warm
10. It is used for homes for insects
11. Because it just comes (grows, naturally)
12. It's just the way God created it
13. To make the tree look nice
14. It's just part of the tree
15. To keep moisture in; to stop the tree from drying out and going rotten
16. To protect against infection
17. It might soak up more water
18. It's like a man growing whiskers
19. To stop insects from eating into the wood
20. For protection from wild animals, winds, rain
21. So the trees wouldn't look bare
22. Maybe it would let the sap run all over the place